

Patent Abstracts of Japan

A 12-15, 19-21, 23, 25

PUBLICATION NUMBER : 08185877
 PUBLICATION DATE : 16-07-96

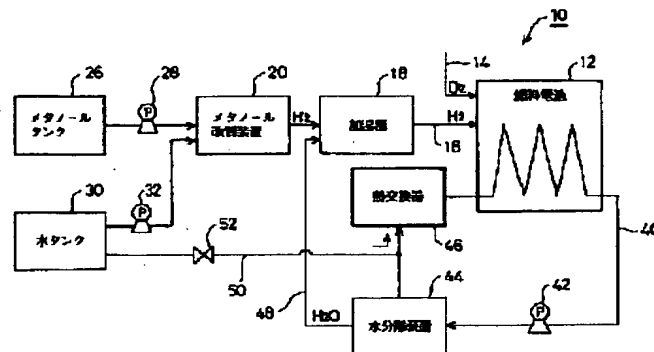
APPLICATION DATE : 28-12-94
 APPLICATION NUMBER : 06340301

APPLICANT : TOYOTA MOTOR CORP;

INVENTOR : NONOBE YASUHIRO;

INT.CL : H01M 8/04

TITLE : FUEL CELL SYSTEM



ABSTRACT : **PURPOSE:** To make the humidification water system of a fuel cell system free from maintenance.

CONSTITUTION: An antifreezing solution made of ethylene glycol mixed with water is circulating in a cooling water circulation passage 40 having a fuel cell 12 as part of a pipeline, and the fuel cell 12 is cooled with the antifreezing solution. Also, the passage 40 is fitted with a water separator device 44 for refining and separating water from the solution via an ultrafiltration film. Water not containing ethylene glycol is refined from the solution circulating through the passage 40, due to the filtration of only water through the film and this refined water is separated from the passage 40. Then, the refined and separated water is supplied to a humidifier 18 laid between a methanol reforming device 20 and the fuel cell 12, as water for humidifying hydrogen gases, and reserved in the humidifier 18. In other words, the water reserved therein for humidifying hydrogen gases is procured from the solution via refining and separating processes.

COPYRIGHT: (C) JPO

FUEL CELL SYSTEM

Patent Number: JP8185877
Publication date: 1996-07-16
Inventor(s): NONOBE YASUHIRO
Applicant(s):: TOYOTA MOTOR CORP
Requested Patent: ☐ JP8185877
Application Number: JP19940340301 19941228
Priority Number(s):
IPC Classification: H01M8/04
EC Classification:
Equivalents:

Abstract

PURPOSE: To make the humidification water system of a fuel cell system free from maintenance.
CONSTITUTION: An antifreezing solution made of ethylene glycol mixed with water is circulating in a cooling water circulation passage 40 having a fuel cell 12 as part of a pipeline, and the fuel cell 12 is cooled with the antifreezing solution. Also, the passage 40 is fitted with a water separator device 44 for refining and separating water from the solution via an ultrafiltration film. Water not containing ethylene glycol is refined from the solution circulating through the passage 40, due to the filtration of only water through the film and this refined water is separated from the passage 40. Then, the refined and separated water is supplied to a humidifier 18 laid between a methanol reforming device 20 and the fuel cell 12, as water for humidifying hydrogen gases, and reserved in the humidifier 18. In other words, the water reserved therein for humidifying hydrogen gases is procured from the solution via refining and separating processes.

Data supplied from the esp@cenet database - I2

RECEIVED
OCT 29 2001
TC 1700

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-185877

(43)Date of publication of application : 16.07.1996

(51)Int.Cl.

H01M 8/04

(21)Application number : 06-340301

(71)Applicant : TOYOTA MOTOR CORP

(22)Date of filing : 28.12.1994

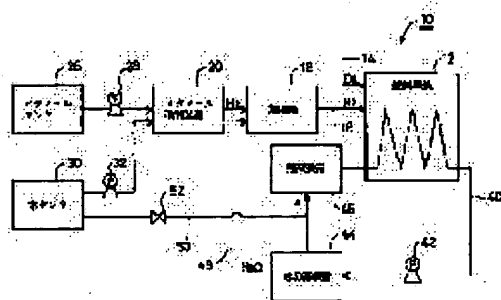
(72)Inventor : NONOBE YASUHIRO

(54) FUEL CELL SYSTEM

(57)Abstract:

PURPOSE: To make the humidification water system of a fuel cell system free from maintenance.

CONSTITUTION: An antifreezing solution made of ethylene glycol mixed with water is circulating in a cooling water circulation passage 40 having a fuel cell 12 as part of a pipeline, and the fuel cell 12 is cooled with the antifreezing solution. Also, the passage 40 is fitted with a water separator device 44 for refining and separating water from the solution via an ultrafiltration film. Water not containing ethylene glycol is refined from the solution circulating through the passage 40, due to the filtration of only water through the film and this refined water is separated from the passage 40. Then, the refined and separated water is supplied to a humidifier 18 laid between a methanol reforming device 20 and the fuel cell 12, as water for humidifying hydrogen gases, and reserved in the humidifier 18. In other words, the water reserved therein for humidifying hydrogen gases is procured from the solution via refining and separating processes.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

【特許請求の範囲】

【請求項1】 水素を含有するガスの供給を受け、該水素含有ガスを燃料ガスとする燃料電池を有する燃料電池システムであって、

水に凝固点降下剤を混合した不凍液を、前記燃料電池を管路の一部とする冷却水系で循環させ、前記燃料電池を冷却する冷却手段と、

前記燃料電池に供給される水素含有ガスを、燃料電池に到る管路において加湿するガス加湿手段と、

前記冷却水系の循環経路に設けられ、循環する前記不凍液から前記凝固点降下剤を含まない水を精製し、該精製した水を前記冷却水系から分離する分離手段と、
該分離した水を、前記循環経路から分岐した経路を経て前記ガス加湿手段にガス加湿用の水として供給する加湿水供給手段とを備えることを特徴とする燃料電池システム。

【請求項2】 請求項1記載の燃料電池システムであって、

前記分離手段により前記冷却水系から分離された水の量に相当する量の水を、前記冷却水系に補給する水補給手段を有する燃料電池システム。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、水素を含有するガスの供給を受け、該水素含有ガスを燃料ガスとする燃料電池を有する燃料電池システムに関する。

【0002】

【従来の技術】一般に、水素リッチな水素ガスを燃料ガスとする燃料電池は、水素イオンを H^+ ($\frac{1}{2}H_2O$) の水和状態で透過する電解質と電極とを有し、電極反応を促進させるための触媒層を介在させてこの電解質を電極で挟持して備える。このような燃料電池は、用いる電解質の種類により種々のもの（例えば、固体高分子型燃料電池、りん酸型燃料電池等）があるが、アノード、カソードの両電極において進行する電極反応は、以下の通りである。

【0003】アノード： $2H_2 \rightarrow 4H^+ + 4e^- \dots \textcircled{1}$

カソード： $4H^+ + 4e^- + O_2 \rightarrow 2H_2O \dots \textcircled{2}$

【0004】そして、アノードに水素ガスが供給されると、アノードでは $\textcircled{1}$ の反応式が進行して水素イオンが生成する。この生成した水素イオンが H^+ ($\frac{1}{2}H_2O$) の水和状態で電解質（固体高分子型燃料電池であれば固体高分子電解質膜）を透過（拡散）してカソードに至り、このカソードに酸素含有ガス、例えば空気が供給されると、カソードでは $\textcircled{2}$ の反応式が進行する。この $\textcircled{1}$ 、 $\textcircled{2}$ の電極反応が各極で進行することで、燃料電池は起電力を呈することになる。

【0005】燃料電池の電解質は、水素イオンが上記した水和状態でアノード側からカソード側に電解質を透過（拡散）する都合上、アノード側で水分が不足する状態

となる。また、固体高分子型燃料電池に用いられる固体高分子電解質膜は、適度な湿潤状態であれば良好な電気伝導性（イオン導電性）を発揮するが、含水率が低下するとイオン導電性が悪化して電解質として機能しなくなり、場合によっては電極反応を停止させてしまう。また、含水率が高すぎてもイオン導電性が悪化する傾向がある。このため、アノードには、燃料ガスとしての水素ガスを供給すると共に、適当な量の水を常時補給する必要がある。従って、燃料電池には、水蒸気にて加湿した水素ガスが供給されている。

【0006】水蒸気加湿された水素ガスを燃料電池に供給するには、種々の方法があるが、最も単純な方法として、次のような技術がよく知られている。つまり、燃料電池に到る水素ガスの供給管経路に加湿装置を設け、この加湿装置によりガス中に燃料電池の手前で水蒸気を添加し、水蒸気添加により加湿した水素ガスを燃料電池に供給する技術が提案されている。

【0007】この加湿装置としては、ガスをバブリングして加湿する加湿器のほか、水蒸気を透過するガス拡散膜を介してガスを加湿する加湿器などがある。

【0008】その一方、上記した電極反応は、いずれも発熱反応である。よって、当該反応の円滑な進行を図るために、循環する冷却水で燃料電池を冷却することが広く行なわれている（特開平5-190193）。

【0009】従って、燃料電池システムでは、燃料電池に加湿済みの水素ガスを供給するための加湿用の水と、燃料電池の冷却用の水とが必要となる。

【0010】

【発明が解決しようとする課題】ところで、燃料電池システムを車両等に搭載する場合には、寒冷地への移動或いは寒冷地域での支障のない稼働を考慮して、水に凝固点降下剤を混合した不凍液を燃料電池の冷却水とすることが一般的である。その一方、水素ガス加湿用の水としては、水蒸気として水素ガスと共にアノードへ供給されることから、電解質膜や電極の触媒の汚濁等を避けるためにも、純水に近似した精製水、即ち凝固点降下剤等の不純物が含有されていない水である必要がある。

【0011】従って、従来の燃料電池システムでは、加湿用の水と冷却用の水とを別系統で別個に必要とすると共に、加湿用の水の補給をも必要とする。そして、この加湿用の水と冷却用の水とを、加湿装置と冷却管路とにそれぞれ用いなければならなかった。このため、加湿用の水の補給といったメンテナンスが必要となり、煩雑であった。この場合、加湿用の水の精製装置を精製される水の供給管路と共に冷却水系とは個別に設ければ、上記のメンテナンスが不要となる。しかし、燃料電池システムにおける加湿水系、冷却水系の構成が複雑化して、その設置スペースの拡大や設置コストの上昇を招くため、現実的な解決にはならない。なお、上記した問題点は、燃料電池システムを搭載した車両等に固有のものではな

い。つまり、燃料電池システムを発電設備として地上に設置したプラントの場合であっても、不凍液を冷却水として用いれば、これら問題点は生じる。

【0012】本発明は、上記問題点を解決するためになされ、簡単な構成で燃料電池システムにおける加温水系についてのメンテナンスフリー化を図ることを目的とする。

【0013】

【課題を解決するための手段】かかる目的を達成するための請求項1記載の燃料電池システムで採用した手段

は、水素を含有するガスの供給を受け、該水素含有ガスを燃料ガスとする燃料電池を有する燃料電池システムであって、水に凝固点降下剤を混合した不凍液を、前記燃料電池を管路の一部とする冷却水系で循環させ、前記燃料電池を冷却する冷却手段と、前記燃料電池に供給される水素含有ガスを、燃料電池に到る管路において加湿するガス加湿手段と、前記冷却水系の循環経路に設けられ、循環する前記不凍液から前記凝固点降下剤を含まない水を精製し、該精製した水を前記冷却水系から分離する分離手段と、該分離した水を、前記循環経路から分岐した経路を経て前記ガス加湿手段にガス加湿用の水として供給する加湿水供給手段とを備えることをその要旨とする。

【0014】請求項2記載の燃料電池システムでは、前記分離手段により前記冷却水系から分離された水の量に相当する量の水を、前記冷却水系に補給する水補給手段を有する。

【0015】

【作用】上記構成を有する請求項1記載の燃料電池システムでは、冷却手段により、不凍液を冷却水系で循環させて燃料電池を冷却する一方、ガス加湿手段により、水素含有ガスを燃料電池に到る管路において加湿する。そして、この加湿手段には、次のようにして、水素含有ガス加湿用の水を供給する。

【0016】冷却水系の循環経路に設けられた分離手段は、循環する不凍液から凝固点降下剤を含まない水を精製し、この精製した水を冷却水系から分離する。この精製された水は、凝固点降下剤を含まないことから、燃料電池に加湿用の水として供給されても、電解質膜や電極の触媒を汚濁することはない。つまり、分離手段により精製・分離された水は、水素含有ガス加湿用の水として支障はない。そして、請求項1記載の燃料電池システムは、この加湿用の水として支障のない水を分離手段により冷却水系から調達し、その水を、加湿水供給手段により、ガス加湿用の水としてガス加湿手段に供給する。このため、ガス加湿用の水の補給作業を要しない。また、冷却水系の循環経路への分離手段の設置、循環経路からガス加湿手段への分岐経路の設置等だけで良く、加湿水系、冷却水系の構成の複雑化を招かない。

【0017】なお、冷却水系では、不凍液がその一部を

分離手段により凝固点降下剤を含まない水に精製・分離されるものの、依然として凝固点降下剤は水に混合されている。よって、冷却水系での不凍液の循環は継続され、燃料電池の冷却に支障はない。

【0018】請求項2記載の燃料電池システムでは、分離手段により冷却水系から分離された水の量に相当する量の水を、水補給手段により冷却水系に補給するので、冷却水系における不凍液の液量や凝固点降下剤の濃度に不意な変動をもたらさない。

【0019】

【実施例】次に、本発明に係る燃料電池システムの好適な実施例について、図面にに基づき説明する。図1は、実施例の燃料電池システム10のブロック図である。

【0020】実施例の燃料電池システム10は、固体高分子型燃料電池（以下、単に燃料電池と略称する）12を中心に備え、燃料電池12には、酸素ガス供給管路14からは酸素含有ガスである空気が、水素ガス供給管路16からはメタノールを水蒸気改質して得られた水素ガス（水素リッチガス、 H_2 : 75%, CO_2 : 25%）が、それぞれ供給される。水素ガス供給管路16の管路には、水素ガス中に水を水蒸気として混在させる加湿器18と、メタノール改質装置20とが設けられている。なお、上記の両管路には適宜な箇所に逆流防止弁が設けられているが、本発明の要旨とは直接関係しないので図示されていない。

【0021】燃料電池12は、固体高分子電解質膜を陽陰の電極で挟持して備え、カソードへの空気とアノードへの水素ガスとの供給を受けて陽陰の電極において上記の①、②の電極反応を進行させる。そして、燃料電池12は、当該電極反応を経て得られた起電力により、図示しない配線を介して外部の駆動機器、例えば電気自動車におけるモータを駆動する。

【0022】メタノール改質装置20は、メタノールタンク26から圧送ポンプ28によりメタノールの供給を受け、水タンク30から圧送ポンプ32により水の供給を受ける。そして、メタノール改質装置20は、改質触媒を介してメタノールと水との改質反応を250～300℃の温度で進行させてメタノールを水蒸気改質し、水素ガスを生成する。この生成された水素ガスは、その下流の加湿器18に送り出される。

【0023】メタノール改質装置20から水素ガスが送り出される加湿器18は、不純物の含有量が少ない水をガス加湿用の水として貯留し、当該貯留水中をガスが通過する間にガスを加湿する周知のバブリング式の加湿器である。そして、この加湿器18は、燃料電池12に供給される水素ガスを、燃料電池12に到る水素ガス供給管路16の管路において加湿する。

【0024】燃料電池システム10は、この他、燃料電池12を管路の一部とする冷却水循環路40を備え、不凍液をこの冷却水循環路40で循環することにより燃料

5

電池12を冷却する。この不凍液は、水にエチレングリコール、グリセリン等の凝固点降下剤を混合したものであり、本実施例では、エチレングリコールを5〜50wt%の濃度で水に混合した不凍液を用いた。

【0025】冷却水循環路40には、管路の不凍液を約100〜700kPa(約1〜7kgf/cm²)の圧力で循環させる圧送ポンプ42が設けられている。また、圧送ポンプ42の下流には、管路の不凍液から水を精製・分離する水分離装置44と、管路の不凍液温度を燃料電池12の冷却に十分な温度まで熱交換(冷却)する熱交換器46とが配設されている。

【0026】水分離装置44は、図2の概念図に示すように、0.005〜0.05μmの径の細孔を有する限外ろ過膜44aを備え、不凍液中の凝固点降下剤であるエチレングリコールの分子径と水分子の分子径との相違を利用して、不凍液における水分子のみを過膜44aを透過させる。従って、圧送ポンプ42により上記した圧力で水分離装置44に不凍液が導入されると、分子径の小さい水分子のみが過膜44aを透過する。このため、水分離装置44では、冷却水循環路40を循環する不凍液からエチレングリコールを含まない水が精製され、この精製された水は冷却水循環路40から分離される。そして、水分離装置44と加湿器18との間には、精製水導入管路48が設けられているので、水分離装置44で精製・分離された水は、冷却水循環路40から分岐した精製水導入管路48を経て加湿器18に水素ガス加湿用の水として供給され、この加湿器18にて貯留される。

【0027】水分離装置44における限外ろ過膜44aは、ポリスルホン、ポリアクリルニトリル、酢酸セルロース、芳香族ナイロン等の種々の材料の膜成形をへて形成され、ポリスルホン製の限外ろ過膜44aとすれば耐久性が高く好ましい。

【0028】本実施例では、水の精製効率を高めるために、水分離装置44を次のように構成した。つまり、水分離装置44は、図3に示すように、中空繊維膜状の限外ろ過膜44aを数百本の束として外筒44bに収納して備え、外筒44bには加湿器18に到る精製水導入管路48が接続されている。そして、この水分離装置44は、その両端をシール材44cにてシールして冷却水循環路40に組み込まれている。従って、水分離装置44は、限外ろ過膜44aの各中空繊維膜内を不凍液を通過させ、中空繊維膜の内部からその外部に水を透過させて上記の水の精製・分離を行ない、加湿器18に水素ガス加湿用の水を供給する。なお、水分離装置44は、中空繊維膜状の限外ろ過膜44aを収納済みの外筒44bを単位としてモジュール化されており、冷却水循環路40へは、当該環路に設けられた対向する支持ブロック45間にシール材44cを介在させて嵌め込むことで組み込まれる。

【0029】また、水タンク30からは、水補給管50

6

が冷却水循環路40に水分離装置44下流で合流するよう設けられており、管路のバルブ52による管路開度の調整を経て、冷却水循環路40に水タンク30から水が補給される。この場合、バルブ52は、上記した水分離装置44により冷却水循環路40の不凍液から精製・分離される水の量に相当する量の水が冷却水循環路40に補給できるよう、管路開度を調整する。つまり、バルブ52は、精製水導入管路48を通過する水の流量に応じて、図示しない制御装置により駆動制御される。なお、この水補給管50にも逆流防止弁が設けられていることは勿論である。

【0030】次に、燃料電池システム10の性能評価について説明する。比較対象となるシステムは冷却水循環路40に水分離装置44を備えないシステムであり、加湿器18には直接純水を補給して水素ガスを加湿する従来の燃料電池システム(従来例システム)と、加湿器18には不凍液を供給してその不凍液にて水素ガスを加湿することとした燃料電池システム(比較例システム)の二つのシステムである。そして、これらの各燃料電池システムについて、各システムにおける燃料電池の電池特性(I-V特性)を電流密度が0〜1.5mA/cm²の範囲に亘って測定した。その結果を図4に示す。

【0031】図4から明らかなように、本実施例の燃料電池システム10では、従来例システムとその電流密度の範囲(0〜1.5mA/cm²)に亘ってほぼ同一の特性を得られた。このため、本実施例の燃料電池システム10のように水分離装置44により不凍液から精製・分離した水で水素ガスを加湿しても、水素ガスの加湿は純水による加湿の場合と同等の電池特性を得ることができるといえる。また、不凍液にて加湿する比較例システムでは、格段に劣る電池特性しか得られない。よって、これらのことから、水分離装置44により不凍液から精製・分離した水は、水素ガス加湿用の水としてなら支障はないといえる。

【0032】そして、本実施例の燃料電池システム10は、水素ガス加湿用の水として支障のない水を水分離装置44により冷却水循環路40の不凍液から調達し、その水を、ガス加湿用の水として加湿器18に供給する。このため、本実施例の燃料電池システム10によれば、加湿器18へガス加湿用の水を補給する作業を要しないので、水素ガスの加湿水系のメンテナンスフリー化を図ることができる。しかも、このメンテナンスフリー化を、冷却水循環路40への水分離装置44の設置、精製水導入管路48の設置といった簡単な構成で実現することができる。また、水素ガス加湿用の加湿水系を燃料電池12の冷却水系である冷却水循環路40から分岐するだけでよいので、その管路構成が簡略化される。よって、構成の簡略化や設置スペースの省スペース化を通して、車両等への燃料電池システム10の搭載性を向上させることができると共に、設置コスト(搭載コスト)を低

減することができる。

【0033】また、燃料電池システム10では、水分離装置44による不凍液からの水の精製・分離により、冷却水循環路40では不凍液から精製・分離された水の量だけ不凍液の液量が減少する。しかし、本実施例の燃料電池システム10では、液量減少分の水を、バルブ52による管路開度の調整を経て水タンク30から冷却水循環路40に補給する。よって、本実施例の燃料電池システム10によれば、冷却水循環路40における不凍液の液量やエチレングリコールの濃度を不用意に変動させないので、不凍液の循環による燃料電池12の冷却効率を、循環流量の変更等を行なうことなく維持できる。

【0034】以上本発明の一実施例について説明したが、本発明はこの様な実施例になんら限定されるものではなく、本発明の要旨を逸脱しない範囲において種々なる態様で実施し得ることは勿論である。

【0035】例えば、本実施例の燃料電池システム10では、不凍液から水を精製・分離するに当たり、不凍液における水分子のみを透過させる過膜44aを有する水分離装置44を用い、不凍液中のエチレングリコールの分子径と水分子の分子径との相違を利用した。しかしこれに限られるものではなく、水とエチレングリコールの沸点の相違を利用して不凍液から水を精製・分離する構成や、メンブレンフィルタ等のろ過膜を用い分子径の相違を利用して不凍液から水を精製・分離する構成等を探ることもできることは勿論である。

【0036】また、加湿器18をバブリング式の加湿器としたが、水蒸気を透過するガス拡散膜を介してガスを加湿する加湿器とすることもできる。

【0037】更に、燃料電池12への水素ガス供給源としてメタノール改質装置20を用いた構成としたが、水素貯蔵機器（例えば、水素ガスボンベや水素貯蔵合金等）から水素ガスを燃料電池12に供給するよう構成することもできる。また、システムにおける燃料電池としては、固体高分子型燃料電池に限らず、りん酸型燃料電池等であってもよいことは勿論である。

【0038】

【発明の効果】以上詳述したように請求項1記載の燃料電池システムでは、水素含有ガス加湿用の水として支障のない水を、冷却水系の循環する不凍液から精製・分離

を経て調達し、その水をガス加湿用の水として供給する。しかも、冷却水系の循環経路への分離手段の設置、循環経路からガス加湿手段への分岐経路の設置等により、水素含有ガス加湿用の加湿水系を燃料電池の冷却水系から分岐するだけでよい。このため、請求項1記載の燃料電池システムによれば、ガス加湿用の水の補給作業を要しないので加湿水系におけるメンテナンスフリー化を図ることができると共に、加湿水系、冷却水系の管路構成の簡略化をも図ることができる。

10 【0039】請求項2記載の燃料電池システムでは、冷却水系から分離された水の量に相当する量の水の冷却水系への補給を通して、冷却水系における不凍液の液量や凝固点降下剤の濃度に不用意な変動をもたらさない。よって、請求項2記載の燃料電池システムによれば、不凍液の循環による燃料電池の冷却効率を、不凍液の循環流量の変更等を行なうことなく維持できる。

【図面の簡単な説明】

【図1】実施例の燃料電池システム10のブロック図。

20 【図2】燃料電池システム10における水分離装置44の概念図。

【図3】実施例の水分離装置44の概略構成を示す模式図。

【図4】実施例の燃料電池システム10と従来例の燃料電池システムおよび比較例の燃料電池システムとの評価の結果を示すグラフ。

【符号の説明】

10…燃料電池システム

12…燃料電池

16…水素ガス供給管路

30 18…加湿器

20…メタノール改質装置

40…冷却水循環路

42…圧送ポンプ

44…水分離装置

44a…限外ろ過膜

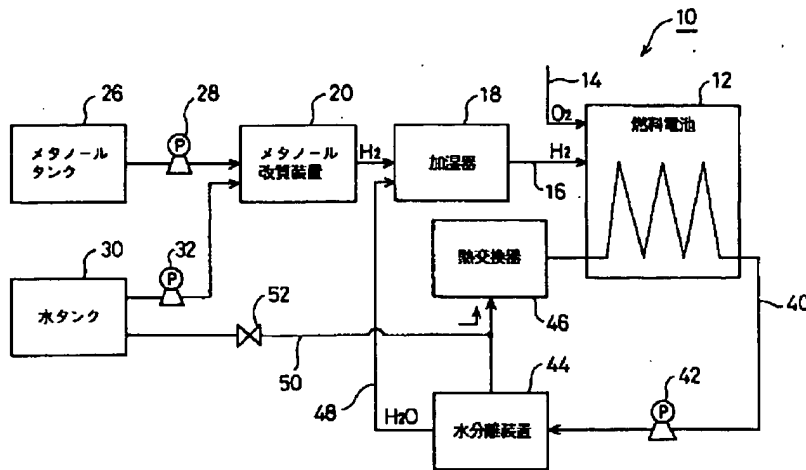
46…熱交換器

48…精製水導入管路

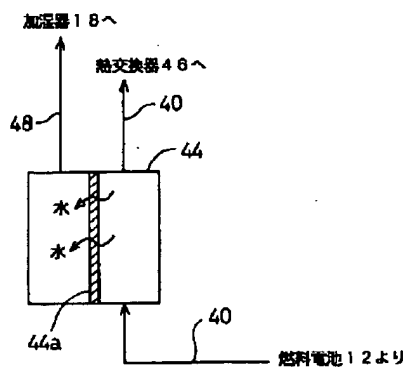
50…水補給管

52…バルブ

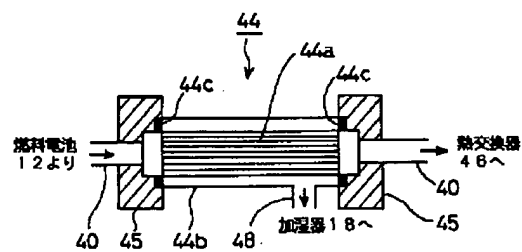
【図1】



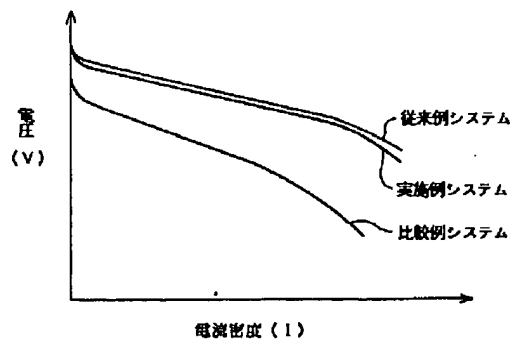
【図2】



【図3】



【図4】



NOTICES

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The fuel cell system which has the fuel cell which receives the supply of the gas containing hydrogen characterized by providing the following, and makes this hydrogen content gas fuel gas. A cooling means to make water circulate through the antifreezing solution which mixed the depression of freezing point agent by the cooling water system which makes the aforementioned fuel cell a part [a duct], and to cool the aforementioned fuel cell. A gas humidification means to humidify the hydrogen content gas supplied to the aforementioned fuel cell in the duct which results in a fuel cell. A separation means to be prepared in the circulation path of the aforementioned cooling water system, to refine the water which does not contain the aforementioned depression of freezing point agent from the aforementioned antifreezing solution through which it circulates, and to separate the this refined water from the aforementioned cooling water system. A humidification water supply means to supply the separated this water to the aforementioned gas humidification means as water for gas humidification through the path which branched from the aforementioned circulation path.

[Claim 2] The fuel cell system which has a water supply means to be a fuel cell system according to claim 1, and to supply the water of the amount equivalent to the amount of the water separated from the aforementioned cooling water system by the aforementioned separation means to the aforementioned cooling water system.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention receives supply of the gas containing hydrogen, and relates to the fuel cell system which has the fuel cell which makes this hydrogen content gas fuel gas.

[0002]

[Description of the Prior Art] general -- hydrogen -- the fuel cell which makes rich hydrogen gas fuel gas has the electrolyte and electrode which penetrate a hydrogen ion in the state of hydration of $H^+ (xH_2O)$, makes the catalyst bed for promoting electrode reaction intervene, and is pinched and equipped with this electrolyte by the electrode. Although such a fuel cell has various things (for example, a solid-state macromolecule type fuel cell, a phosphoric acid type fuel cell, etc.) according to the kind of electrolyte to be used, the electrode reaction which advances in the two electrodes of an anode and a cathode is as follows.

[0003] Anode: $2H_2 \rightarrow 4H^+ + 4e^-$ -- ** cathode: $4H^+ + 4e^- + O_2 \rightarrow 2H_2O$ -- ** [0004] And if hydrogen gas is supplied to an anode, in an anode, the reaction formula of ** will advance and a hydrogen ion will generate. If this generated hydrogen ion penetrates an electrolyte (if it is a solid-state macromolecule type fuel cell solid-state polyelectrolyte film) in the state of hydration of $H^+ (xH_2O)$ (diffusion), it results in a cathode and oxygen content gas, for example, air, is supplied to this cathode, the reaction formula of ** will advance in a cathode. A fuel cell will present electromotive force because the electrode reaction of this ** and ** advances on each pole.

[0005] The electrolyte of a fuel cell will be in the state where moisture runs short on the convenience which penetrates an electrolyte to a cathode side (diffusion), and by the anode side from an anode side in the state of the hydration which the hydrogen ion described above. Moreover, although the solid-state polyelectrolyte film used for a solid-state macromolecule type fuel cell will demonstrate good electrical conductivity (ion conductivity) if it is in a moderate damp or wet condition, if a water content falls, ion conductivity will get worse, and it stops functioning as an electrolyte, and will stop electrode reaction depending on the case. Moreover, even if a water content is too high, there is an inclination for ion conductivity to get worse. For this reason, while supplying the hydrogen gas as fuel gas, it is necessary to an anode to always supply a suitable quantity of water. Therefore, the hydrogen gas humidified with the steam is supplied to the fuel cell.

[0006] Although there are various methods in order to supply the hydrogen gas by which steam humidification was carried out to a fuel cell, the following technology is well known as simplest method. That is, humidification equipment is formed in the supply pipe path of the hydrogen gas which results in a fuel cell, a steam is added before a fuel cell in gas with this humidification equipment, and the technology which supplies the hydrogen gas humidified by steaming to a fuel cell is proposed.

[0007] There is a humidifier which humidifies gas through the gaseous diffusion film which penetrates a steam besides the humidifier which carries out bubbling of the gas and humidifies it as this humidification equipment.

[0008] On the other hand, each of the above-mentioned electrode reaction is exothermic reaction. Therefore, in order to aim at smooth advance of the reaction concerned, cooling a fuel cell by the cooling water through which it circulates is performed widely (JP, 5-190193, A).

[0009] Therefore, in a fuel cell system, the water for the humidification for supplying hydrogen gas [finishing / humidification] and the water for cooling of a fuel cell are needed for a fuel cell.

[0010]

[Problem(s) to be Solved by the Invention] By the way, when it carries a fuel cell system in vehicles etc., it is common to use as the cooling water of a fuel cell the antifreezing solution which mixed the depression of freezing point agent in water in consideration of operation without movement to a cold district or the trouble in a cold district region. It is necessary to be water which impurities, such as the purified water approximated to pure water, i.e., a depression of freezing point agent etc., do not contain in order to avoid the electrolyte film since an anode is supplied with hydrogen gas as a steam as water for hydrogen gas humidification on the other hand, corruption of the catalyst of an electrode, etc.

[0011] Therefore, in the conventional fuel cell system, while needing the water for humidification, and the water for cooling separately in another system, supply of the water for humidification is also needed. And the water for this humidification and the water for cooling had to be used for humidification equipment and the cooling pipe way, respectively. For this reason, a maintenance called supply of the water for humidification was needed, and it was complicated. In this case, if it prepares individually [a cooling water system] with the supply pipe way of water by which the refiner of the water for humidification is refined, the above-mentioned maintenance will become unnecessary. However, it does not become realistic solution, in order to complicate the composition of the humidification drainage system in a fuel cell system, and a cooling water system and to cause expansion of the installation space, and elevation of installation cost. In addition, the above-mentioned trouble is not peculiar to the vehicles carrying the fuel cell system etc. That is, these troubles will be produced if the antifreezing solution is used as cooling water even if it is the case of the plant which considered the fuel cell system as the power generation facility, and installed it on the ground.

[0012] this invention is made in order to solve the above-mentioned trouble, and it aims at attaining maintenance-free-ization about the humidification drainage system in a fuel cell system with easy composition.

[0013]

[Means for Solving the Problem] The means adopted by the fuel cell system according to claim 1 for attaining this purpose It is the fuel cell system which has the fuel cell which receives supply of the gas containing hydrogen and makes this hydrogen content gas fuel gas. A

cooling means to make water circulate through the antifreezing solution which mixed the depression of freezing point agent by the cooling water system which makes the aforementioned fuel cell a part [a duct], and to cool the aforementioned fuel cell, A gas humidification means to humidify the hydrogen content gas supplied to the aforementioned fuel cell in the duct which results in a fuel cell, A separation means to be prepared in the circulation path of the aforementioned cooling water system, to refine the water which does not contain the aforementioned depression of freezing point agent from the aforementioned antifreezing solution through which it circulates, and to separate the this refined water from the aforementioned cooling water system, Let it be the summary to have a humidification water supply means to supply the separated this water to the aforementioned gas humidification means as water for gas humidification through the path which branched from the aforementioned circulation path.

[0014] In a fuel cell system according to claim 2, it has a water supply means to supply the water of the amount equivalent to the amount of the water separated from the aforementioned cooling water system by the aforementioned separation means to the aforementioned cooling water system.

[0015]

[Function] In the fuel cell system according to claim 1 which has the above-mentioned composition, while circulating the antifreezing solution by the cooling water system and cooling a fuel cell by the cooling means, hydrogen content gas is humidified by the gas humidification means in the duct which results in a fuel cell. And the water for hydrogen content gas humidification is supplied to this humidification means as follows.

[0016] The separation means prepared in the circulation path of a cooling water system refines the water which does not contain a depression of freezing point agent from the antifreezing solution through which it circulates, and separates this refined water from a cooling water system. Since this refined water does not contain a depression of freezing point agent, even if a fuel cell is supplied as water for humidification, it does not corrupt the catalyst of an electrolyte film or an electrode. That is, the water refined and separated by the separation means is convenient as water for hydrogen content gas humidification. And a fuel cell system according to claim 1 supplies the water which is convenient as water for this humidification from a cooling water system by the separation means, and supplies the water to a gas humidification means as water for gas humidification by the humidification water supply means. For this reason, supply work of the water for gas humidification is not required. Moreover, installation of the separation means to the circulation path of a cooling water system, only installation of the branching path from a circulation path to a gas humidification means, etc. are required, and complication of the composition of a humidification drainage system and a cooling water system is not caused.

[0017] In addition, in the cooling water system, although the antifreezing solution is refined and separated in the part by the water which does not contain a depression of freezing point agent by the separation means, the depression of freezing point agent is still mixed by water. Therefore, circulation of the antifreezing solution in a cooling water system is continued, and it is convenient to cooling of a fuel cell.

[0018] In a fuel cell system according to claim 2, since the water of the amount equivalent to the amount of the water separated from the cooling water system by the separation means is supplied to a cooling water system by the water supply means, an unprepared change is not brought to the volume of the antifreezing solution or the concentration of a depression of freezing point agent in a cooling water system.

[0019]

[Example] Next, the suitable example of the fuel cell system concerning this invention is explained based on a drawing. Drawing 1 is the block diagram of the fuel cell system 10 of an example.

[0020] It has the fuel cell system 10 of an example focusing on the solid-state macromolecule type fuel cell (it is only hereafter called a fuel cell for short) 12, and the hydrogen gas (hydrogen-rich gas, H₂:75%, CO₂:25%) obtained by the air which is oxygen content gas carrying out steam reforming of the methanol from the hydrogen gas supply pipe way 16 is supplied to a fuel cell 12 from the oxygen gas supply pipe way 14, respectively. The humidifier 18 which makes water intermingled as a steam, and the methanol reformer 20 are formed into hydrogen gas at the duct of the hydrogen gas supply pipe way 16. In addition, although the check valve is prepared in the part proper to both the above-mentioned ducts, since it is not directly related to the summary of this invention, it is not illustrated.

[0021] A fuel cell 12 is pinched and equipped with a solid-state polyelectrolyte film by the electrode of ****, and electrode reaction of above ** and ** is advanced in the electrode of **** in response to supply with the air to a cathode, and the hydrogen gas to an anode. And a fuel cell 12 drives the motor in an external driver, for example, an electric vehicle, through the wiring which does not illustrate with the electromotive force pass the electrode reaction concerned.

[0022] The methanol reformer 20 receives supply of a methanol from the methanol tank 26 with the feeding pump 28, and receives supply of water from a water tank 30 with the feeding pump 32. And the methanol reformer 20 advances the reforming reaction of a methanol and water at the temperature of 250-300 degrees C through a reforming catalyst, carries out steam reforming of the methanol, and generates hydrogen gas. This generated hydrogen gas is sent out to the humidifier 18 of the lower stream of a river.

[0023] The humidifier 18 with which hydrogen gas is sent out from the methanol reformer 20 is a humidifier of the bubbling formula of the common knowledge which humidifies gas, while the content of an impurity stores few water as water for gas humidification and gas passes through the inside of the reservoir water concerned. And this humidifier 18 humidifies the hydrogen gas supplied to a fuel cell 12 in the duct of the hydrogen gas supply pipe way 16 which results in a fuel cell 12.

[0024] In addition to this, the fuel cell system 10 is equipped with the cooling-water-flow way 40 which makes a fuel cell 12 a part. [a duct], and cools a fuel cell 12 by circulating through the antifreezing solution on this cooling-water-flow way 40. This antifreezing solution mixed depression of freezing point agents, such as ethylene glycol and a glycerol, in water, and the antifreezing solution which mixed ethylene glycol in water by 5 - 50wt% concentration was used for it by this example.

[0025] The feeding pump 42 made to circulate through the antifreezing solution of a duct by the pressure of about 100 to 700 kPa (about one to 7 kgf/cm²) is formed in the cooling-water-flow way 40. Moreover, the water decollator 44 which refines and separates water from the antifreezing solution of a duct, and the heat exchanger 46 which carries out the heat exchange (cooling) of the antifreezing-solution temperature of a duct to sufficient temperature for cooling of a fuel cell 12 are arranged in the lower stream of a river of the feeding pump 42.

[0026] The water decollator 44 is equipped with ultrafiltration-membrane 44a which has the pore of a 0.005-0.05-micrometer diameter, and makes **** 44a penetrate only the moisture child in the antifreezing solution using the difference with the diameter of a molecule of ethylene glycol and a moisture child's diameter of a molecule which are a depression of freezing point agent in the antifreezing solution, as shown in the conceptual diagram of drawing 2. Therefore, if the antifreezing solution is introduced into the water decollator 44 by the pressure described above with the feeding pump 42, only the small moisture child of the diameter of a molecule will penetrate **** 44a.

For this reason, in the water decollator 44, the water which does not contain ethylene glycol from the antifreezing solution which circulates through the cooling-water-flow way 40 is refined, and this refined water is separated from the cooling-water-flow way 40. And since the purified-water introduction duct 48 is formed between the water decollator 44 and the humidifier 18, the water refined and separated by the water decollator 44 is supplied to a humidifier 18 as water for hydrogen gas humidification through the purified-water introduction duct 48 which branched from the cooling-water-flow way 40, and is stored with this humidifier 18.

[0027] Ultrafiltration-membrane 44a in the water decollator 44 is formed through film fabrication of a polysulfone, the poly acrylic nitril, cellulose acetate, aromatic nylon, etc. of various material, and ultrafiltration-membrane 44a made from a polysulfone, then its endurance are highly desirable.

[0028] In order to raise the refining efficiency of water, the water decollator 44 consisted of this examples as follows. That is, the water decollator 44 contains and equips outer case 44b with hollow-fiber film-like ultrafiltration-membrane 44a as hundreds of bunches, as shown in drawing 3, and the purified-water introduction duct 48 which results in a humidifier 18 is connected to outer case 44b. And this water decollator 44 carries out the seal of the ends in sealant 44c, and is included in the cooling-water-flow way 40. Therefore, the water decollator 44 passes the antifreezing solution for the inside of each hollow-fiber film of ultrafiltration-membrane 44a, makes the exterior penetrate water from the interior of a hollow-fiber film, performs refining and separation of the above-mentioned water, and supplies the water for hydrogen gas humidification to a humidifier 18. In addition, the modularization of the water decollator 44 is carried out considering outer case 44b [finishing / receipt of hollow-fiber film-like ultrafiltration-membrane 44a] as a unit, and it is included in the cooling-water-flow way 40 by making sealant 44c intervene and inserting in between the support blocks 45 which were formed in the **** concerned and which counter.

[0029] Moreover, from the water tank 30, it is prepared so that the water supply pipe 50 may join the cooling-water-flow way 40 on water decollator 44 lower stream of a river, and water is supplied to the cooling-water-flow way 40 from a water tank 30 through adjustment of the duct opening by the bulb 52 of a duct. In this case, a bulb 52 adjusts duct opening so that the water of the amount equivalent to the amount of the water refined and separated from the antifreezing solution of the cooling-water-flow way 40 by the above-mentioned water decollator 44 can supply the cooling-water-flow way 40. That is, according to the flow rate of the water which passes the purified-water introduction duct 48, drive control of the bulb 52 is carried out by the control unit which is not illustrated. In addition, of course, the check valve is prepared also in this water supply pipe 50.

[0030] Next, the performance evaluation of the fuel cell system 10 is explained. The system used as the candidate for comparison is a system which does not equip the cooling-water-flow way 40 with the water decollator 44, and they are two systems, the conventional fuel cell system (conventional example system) which supplies direct pure water to a humidifier 18, and humidifies hydrogen gas, and the fuel cell system (example system of comparison) to which it was presupposed that the antifreezing solution is supplied to a humidifier 18 and hydrogen gas is humidified with the antifreezing solution. And current density is the cell property (I-V property) of a fuel cell [in / each system / systems / fuel cell / these / each] / 0 - 1.5 mA/cm² It measured / the range /. The result is shown in drawing 4.

[0031] In the fuel cell system 10 of this example, the almost same property was able to be acquired [the range of the conventional example system and its current density (0 - 1.5 mA/cm²)] so that clearly from drawing 4. For this reason, even if it humidifies hydrogen gas with the water refined and separated from the antifreezing solution by the water decollator 44 like the fuel cell system 10 of this example, it can be said that humidification of hydrogen gas can acquire a cell property equivalent to the case of humidification by pure water. moreover, in the example system of comparison humidified with the antifreezing solution, only the cell property which is markedly alike and is inferior is acquired Therefore, it can be said from these things that the water refined and separated from the antifreezing solution by the water decollator 44 is convenient in any way as water for hydrogen gas humidification.

[0032] And the fuel cell system 10 of this example supplies the water which is convenient as water for hydrogen gas humidification from the antifreezing solution of the cooling-water-flow way 40 by the water decollator 44, and supplies the water to a humidifier 18 as water for gas humidification. For this reason, since a humidifier 18 does not take the work which supplies the water for gas humidification according to the fuel cell system 10 of this example, maintenance-free-ization of the humidification drainage system of hydrogen gas can be attained. And this maintenance-free-ization is realizable with easy composition, such as installation of the water decollator 44 to the cooling-water-flow way 40, and installation of the purified-water introduction duct 48. Moreover, since what is necessary is just to branch the humidification drainage system for hydrogen gas humidification from the cooling-water-flow way 40 which is the cooling water system of a fuel cell 12, the duct composition is simplified. Therefore, while being able to improve the loading nature of the fuel cell system 10 to vehicles etc. through simplification of composition, or the formation of a ** space of an installation space, installation cost (loading cost) can be reduced.

[0033] Moreover, only in the amount of the water refined and separated from the antifreezing solution, in the fuel cell system 10, the volume of the antifreezing solution decreases on the cooling-water-flow way 40 by refining and separation of the water from the antifreezing solution by the water decollator 44. However, in the fuel cell system 10 of this example, the water of a volume decrement is supplied to the cooling-water-flow way 40 from a water tank 30 through adjustment of the duct opening by the bulb 52. Therefore, according to the fuel cell system 10 of this example, since the volume of the antifreezing solution or the concentration of ethylene glycol in the cooling-water-flow way 40 are not fluctuated carelessly, the cooling efficiency of the fuel cell 12 by circulation of the antifreezing solution can be maintained, without making a change of the amount of circulating flows etc.

[0034] Although one example of this invention was explained above, as for this invention, it is needless to say that it can carry out in the mode which becomes various in the range which is not limited to such an example at all and does not deviate from the summary of this invention.

[0035] For example, in the fuel cell system 10 of this example, the difference with the diameter of a molecule of the ethylene glycol in the antifreezing solution and a moisture child's diameter of a molecule was used in refining and separating water from the antifreezing solution using the water decollator 44 which has **** 44a which makes only the moisture child in the antifreezing solution penetrate. However, of course, not the thing restricted to this but the composition which uses a difference of the boiling point of water and ethylene glycol, and refines and separates water from the antifreezing solution, the composition which uses the difference of the diameter of a molecule using filtration films, such as a membrane filter, and refines and separates water from the antifreezing solution can also be taken.

[0036] Moreover, although the humidifier 18 was used as the humidifier of a bubbling formula, it can also consider as the humidifier which humidifies gas through the gaseous diffusion film which penetrates a steam.

[0037] Furthermore, although considered as the composition using the methanol reformer 20 as a hydrogen gas source of supply to a fuel cell 12, it can also constitute so that hydrogen gas may be supplied to a fuel cell 12 from hydrogen storage devices (for example, a

hydrogen chemical cylinder, a hydrogen storage material, etc.). Moreover, of course as a fuel cell in a system, you may be not only a solid-state macromolecule type fuel cell but a phosphoric acid type fuel cell etc.

[0038]

[Effect of the Invention] As explained in full detail above, in a fuel cell system according to claim 1, the water which is convenient as water for hydrogen content gas humidification is supplied through refining and separation from the antifreezing solution through which a cooling water system circulates, and the water is supplied as water for gas humidification. And what is necessary is just to branch the humidification drainage system for hydrogen content gas humidification from the cooling water system of a fuel cell by installation of the separation means to the circulation path of a cooling water system, installation of the branching path from a circulation path to a gas humidification means, etc. For this reason, since supply work of the water for gas humidification is not required, while being able to attain maintenance-free-ization in a humidification drainage system according to the fuel cell system according to claim 1, simplification of the duct composition of a humidification drainage system and a cooling water system can also be attained.

[0039] In a fuel cell system according to claim 2, an unprepared change is not brought to the volume of the antifreezing solution or the concentration of a depression of freezing point agent in a cooling water system through supply to the cooling water system of the water of the amount equivalent to the amount of the water separated from the cooling water system. Therefore, according to the fuel cell system according to claim 2, the cooling efficiency of the fuel cell by circulation of the antifreezing solution can be maintained, without making a change of the amount of circulating flows of the antifreezing solution etc.

[Translation done.]